National Aeronautics and Space Administration

ARSET

Applied Remote Sensing Training

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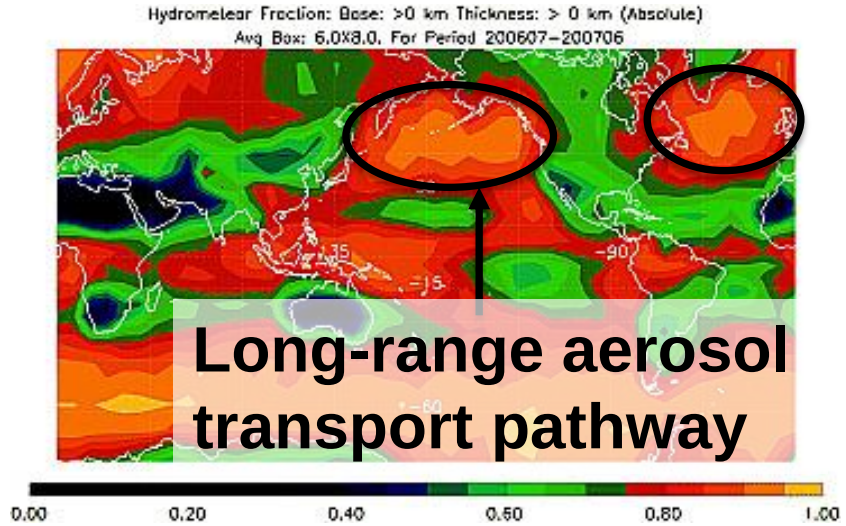
NASA SPoRT Near Real-Time Aerosol Optical Depth Composite Product

Aaron Naeger – August 3, 2016

Introduction to Satellite Remote Sensing for Air Quality Applications

Background (1)

- The use of aerosol retrievals from single satellite sensors alone can provide an incomplete representation of the aerosol spatial distribution due to cloud cover, sun glint, and sensor limitations (e.g., spatial resolution, scan coverage).
- Aerosol optical depth (AOD) retrieval algorithms use cloud screening techniques to disregard AOD in cloudy regions due to difficultly in separating visible reflectance of aerosols and clouds.
  - Average cloud cover exceeded 90% throughout the North Pacific and North Atlantic between July 2006 and June 2007 (Mace et al., 2009).
  - AOD retrievals for absorbing aerosols above clouds have been developed (Meyers et al., 2015), but rely on additional assumptions often leading to uncertainties > 50%.



Mace, G. G., Zhang, Q., Vaughan, M., Marchand, R., Stephens, G., Trepte, C., and Winker, D.: A description of hydrometer layer occurrence statistics derived from the first year of merged Cloudsat and CALIPSO data, J. Geophys. Res., 114, D00A26, doi:10.1029/2007JD009755, 2009.

Meyer, K., Platnick, S., and Zhang, Z.: Simultaneously inferring above-cloud absorbing aerosol optical thickness and underlying liquid phase cloud optical and microphysical properties using MODIS, J. Geophys. Res., 120, 5524–5547. doi:10.1002/2015JD023128, 2015.

Background (2)

Low-earth orbiting (LEO) sensors

- Advantages
  - Frequent overpasses at high latitudes
  - Numerous spectral bands

- Disadvantages
  - Generally only observe the same location once per daytime period
  - Can have significant data coverage and sunglint gaps

Geostationary earth orbit (GEO) sensors

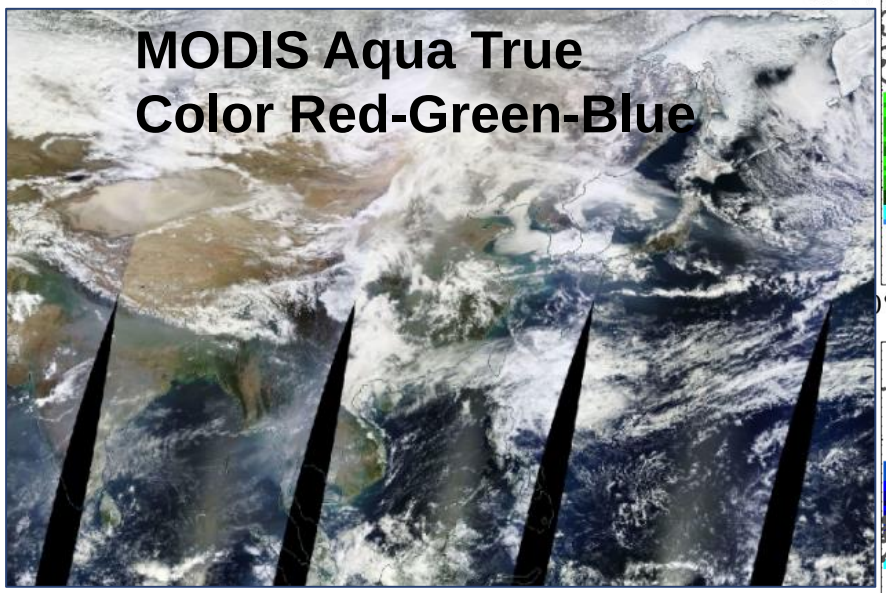
- Advantages
  - Frequent scans over same region
  - No data coverage gaps over field of view

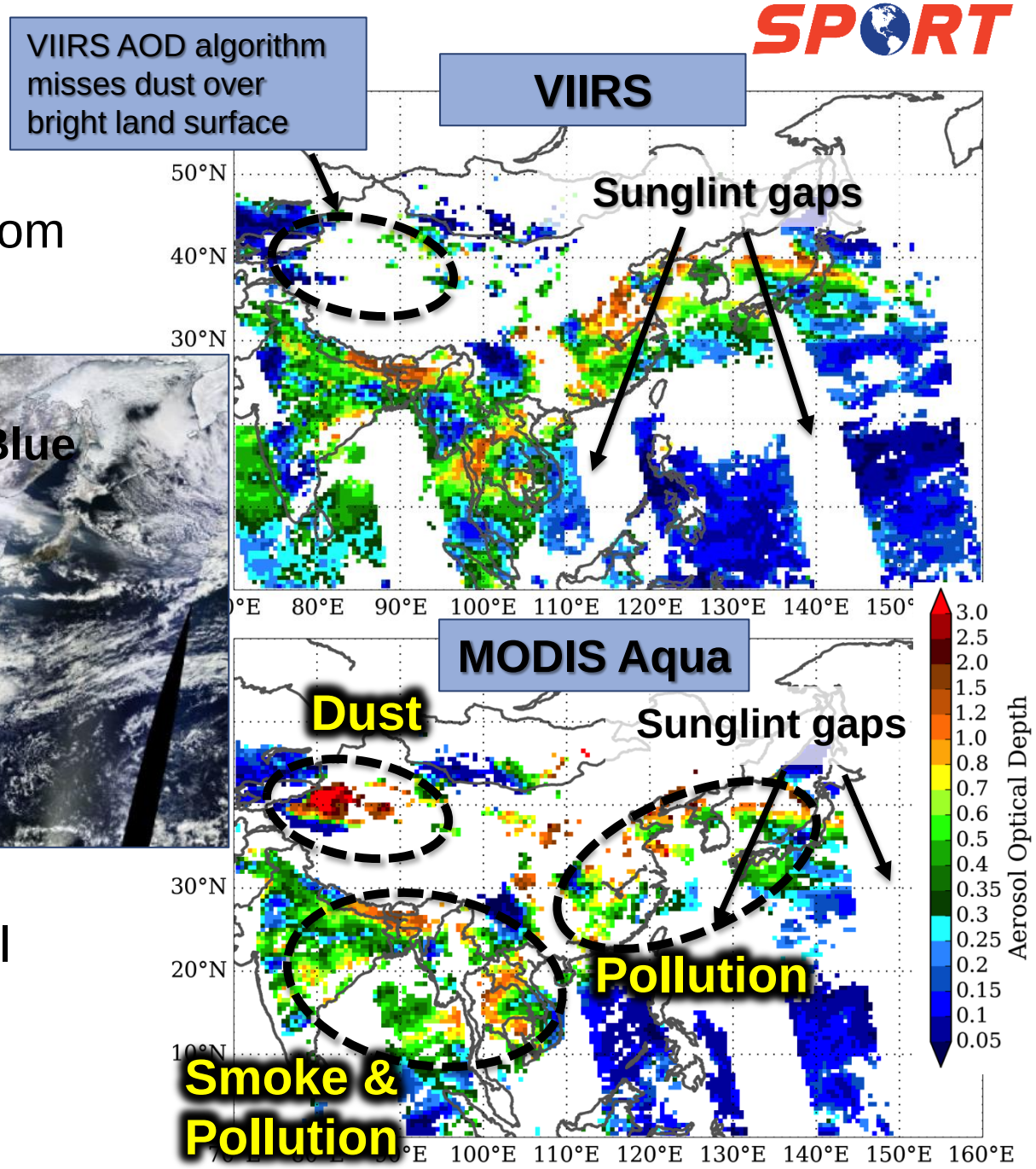
- Disadvantages
  - Can have limited number of aerosol retrievals at high latitudes
  - Fewer spectral bands

Background (3)

MODIS and VIIRS AOD for 6-hour period from 0300-0900 UTC 4 March 2016

- Aerosol contaminated regions include:
  - Pollution over eastern China and western Pacific
  - Smoke and pollution over Southeast Asia
  - Dust extending from Taklimakan Desert to over northern China
- Data coverage/sunglint gaps and cloud cover reduce our understanding of the aerosol spatial distribution





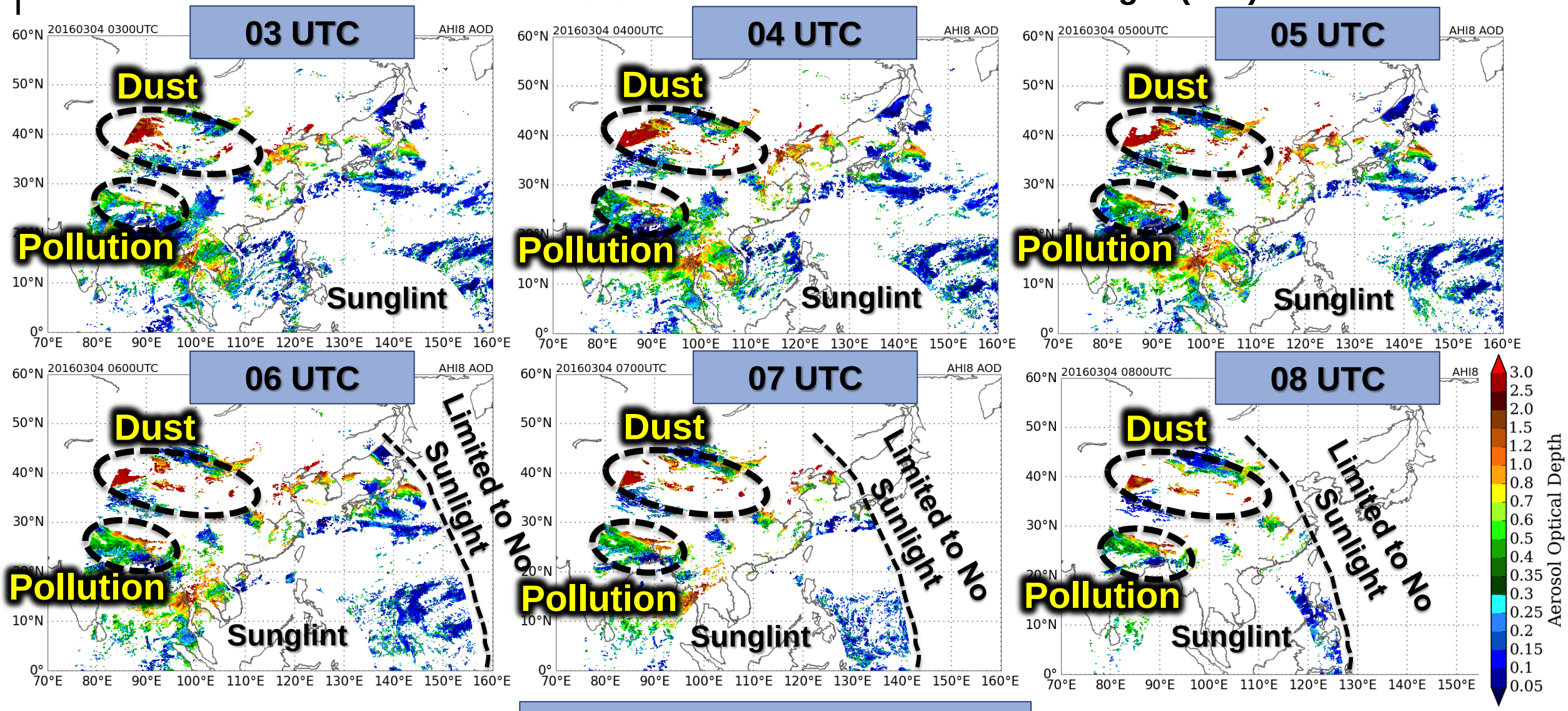
Product Development (1)

- **Goal**: Develop a near-global, near real-time (NRT) comprehensive representation of the aerosol spatial distribution through merging multi-sensor AOD retrievals
  - Utilize the complementary advantages/disadvantages of LEO and GEO sensors to develop a robust merged product
- **NASA SPoRT AOD Composite Product**
  - MODIS AOD product downloaded from NASA's Land and Atmosphere Near real-time Capability for Earth observing system (LANCE) data system
  - VIIRS AOD product downloaded from the NOAA Comprehensive Large Array-data Stewardship System (CLASS) subscription service
  - Develop our own AOD retrieval algorithms for the AHI and GOES sensors.
  - The LEO and GEO AOD retrievals are regridded onto a common 0.5°x0.5° grid domain

Naeger, A. R., Gupta, P., Zavodsky, B. T., and McGrath, K. M.: Monitoring and tracking the trans-Pacific transport of aerosols using multi-satellite aerosol optical depth composites, Atmos. Meas. Tech., 9, 2463-2482, doi:10.5194/amt-9-2463-2016, 2016.

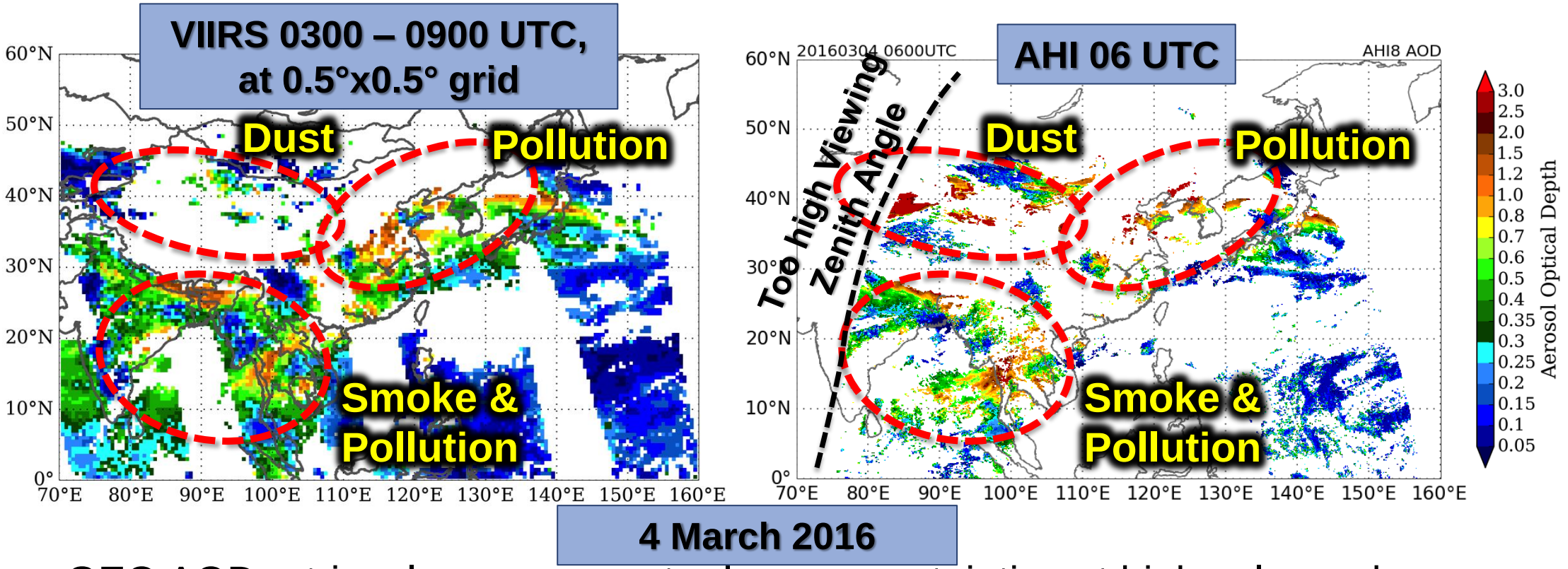
Product Development (2)

Advanced Himawari Imager (AHI) AOD time series



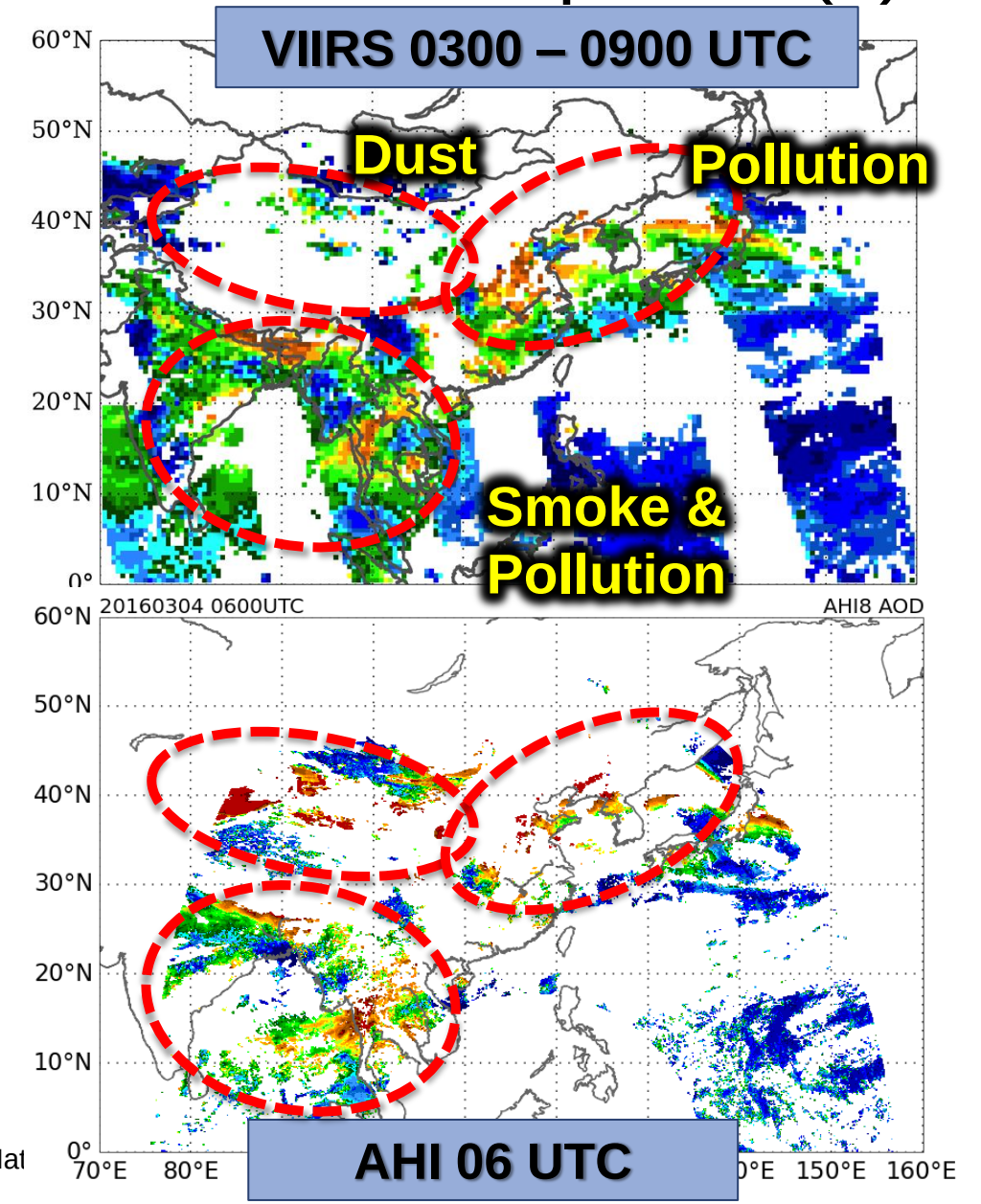
4 March 2016

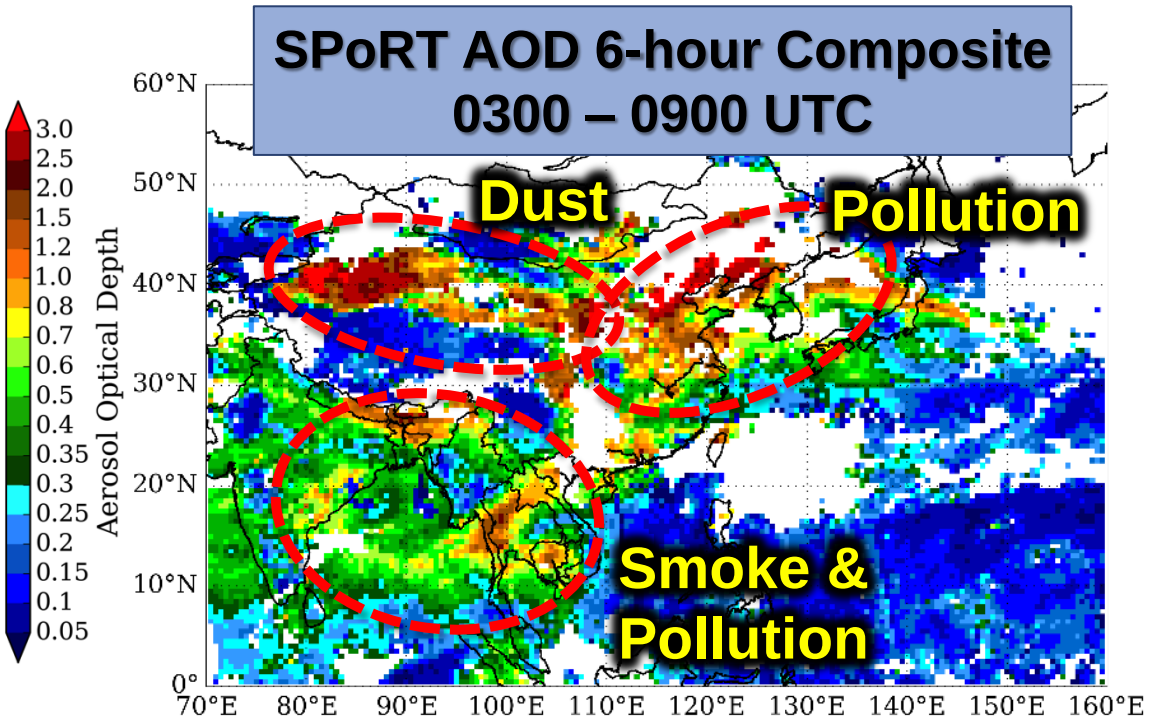
Product Development (3)



- GEO AOD retrievals can encounter large uncertainties at high solar and viewing zenith angles which restricts AOD coverage over field of view
  - LEO AOD helps supplement the lack of GEO AOD in these regions
  - LEO sensors have much higher spatial resolution compared to GEO sensors at these higher solar and viewing zenith angles

Product Development (4)



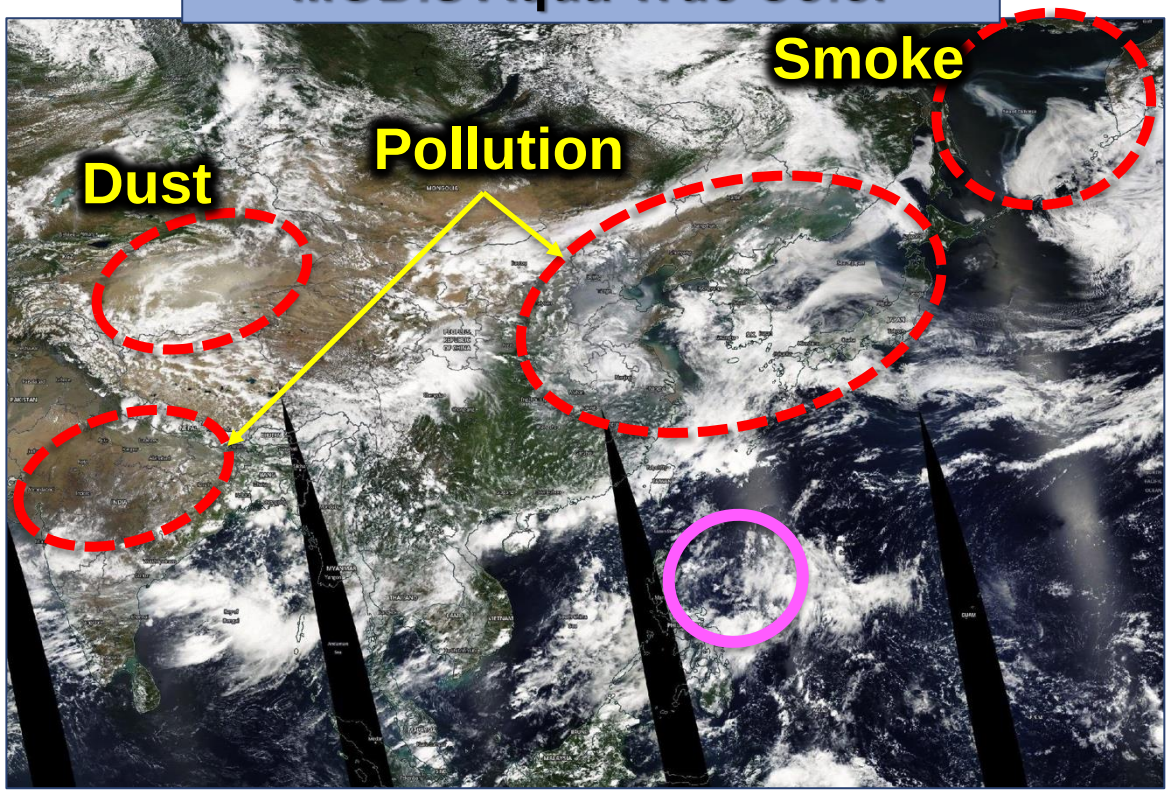


- Merged GEO/LEO product leads to increased aerosol spatial distribution while maintaining high quality nature of the original products
  - Dust transport from Taklimakan Desert to northern China is well represented
  - Pollution is hampering a large region over eastern China and the western Pacific
  - Biomass burning aerosols cover a substantial portion of Southeast Asia

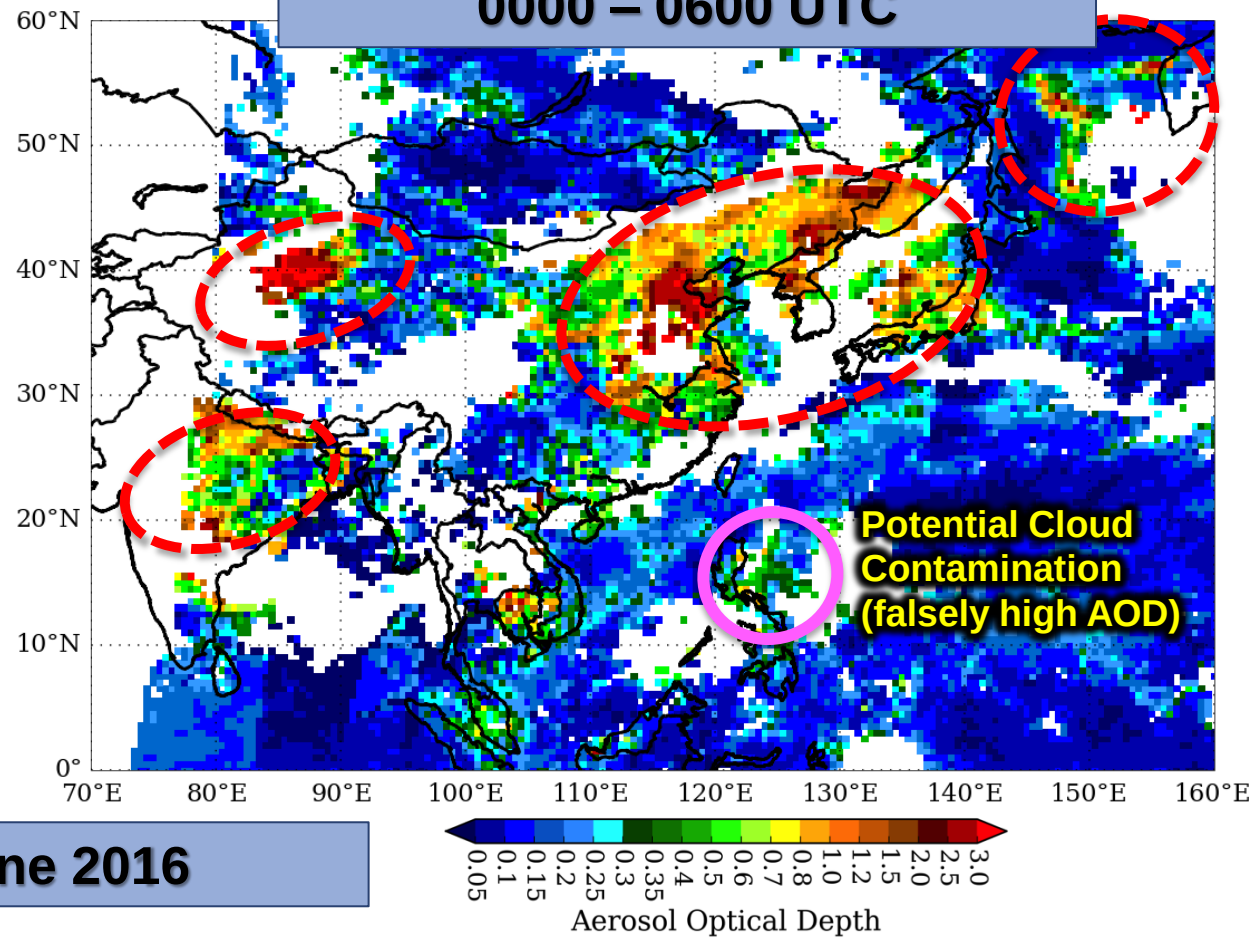
Applications (1)

- Local and regional aerosol/air quality monitoring

MODIS Aqua True Color



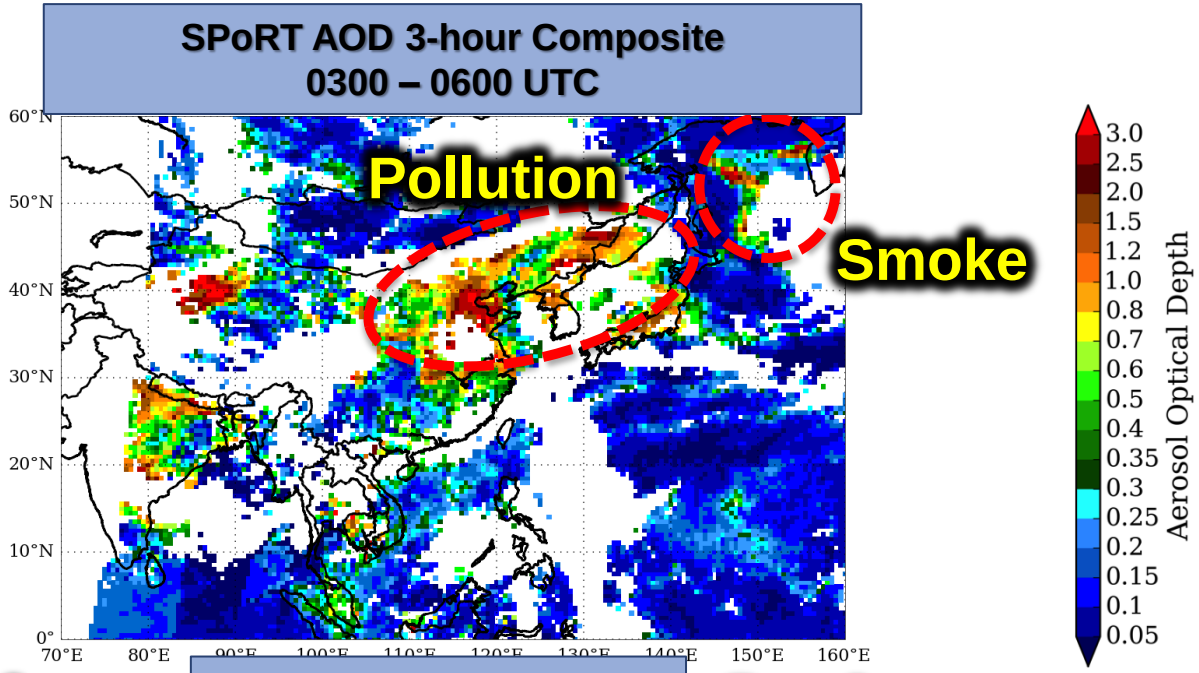
SPoRT AOD 6-hour Composite
0000 – 0600 UTC



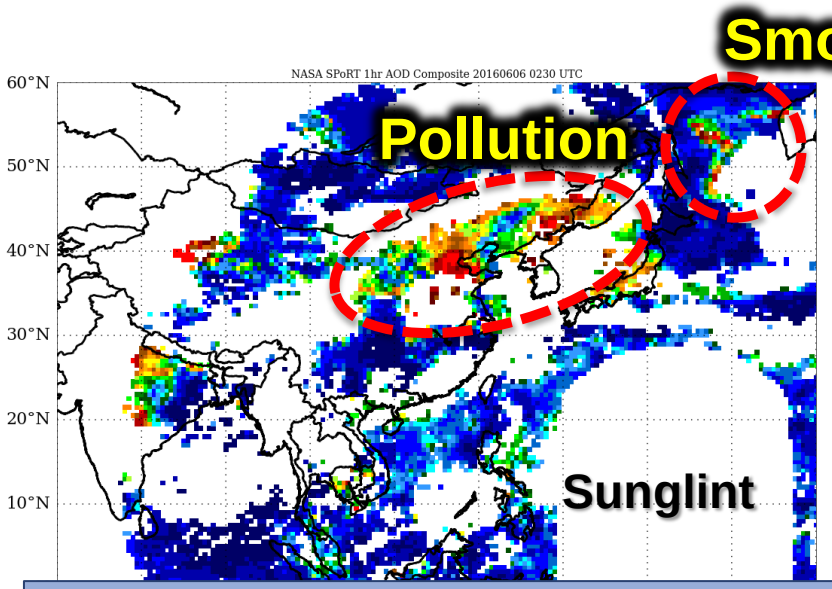
6 June 2016

Applications (2)

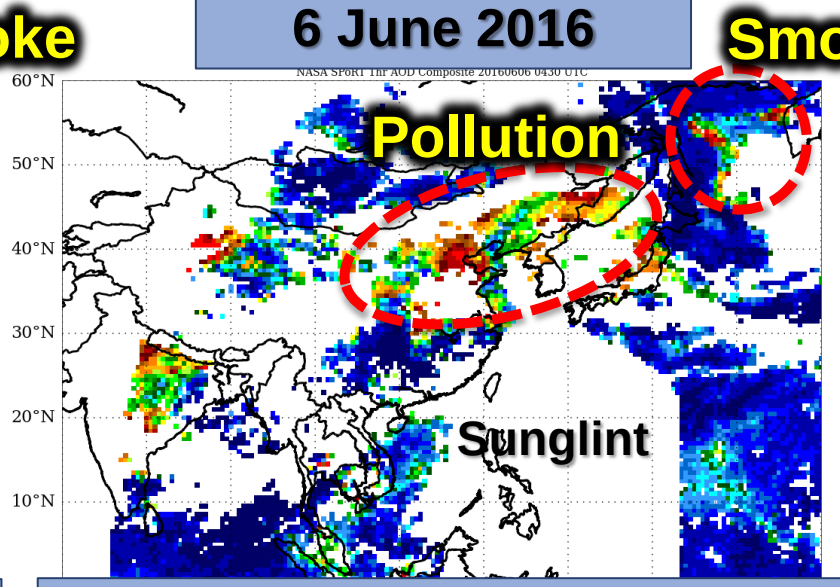
- Shorter-term products can provide more near real-time monitoring of air quality



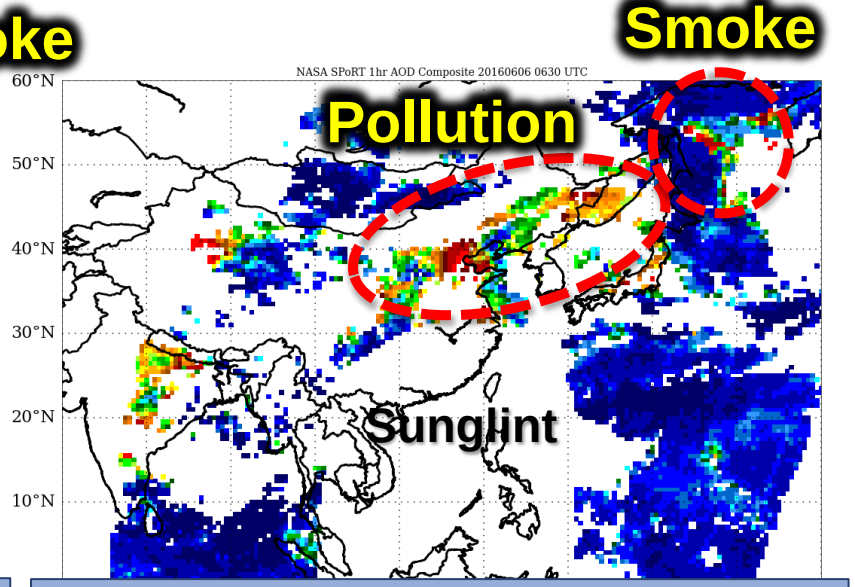
6 June 2016



SPoRT AOD 1-hour Composite
0200 – 0300 UTC



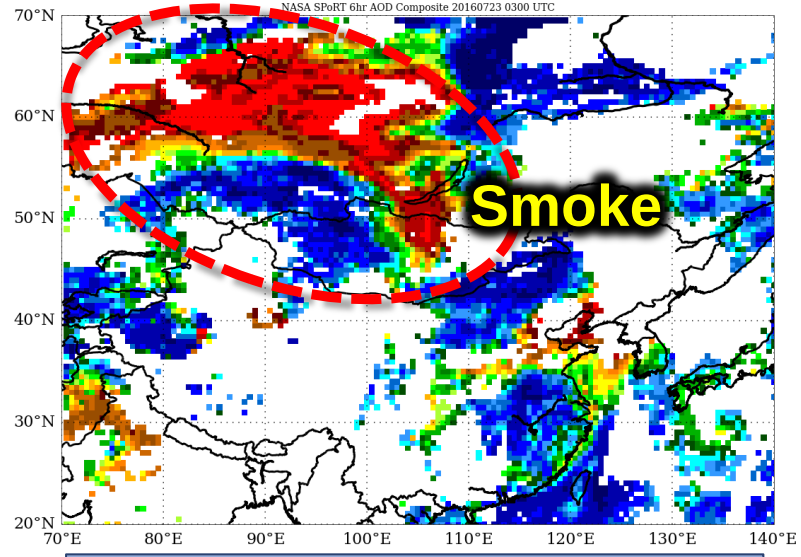
SPoRT AOD 1-hour Composite
0400 – 0500 UTC



SPoRT AOD 1-hour Composite
0600 – 0700 UTC

Applications (3): SPoRT AOD Composite vs. MODIS True Color

- Monitoring and tracking the long-range transport of aerosols



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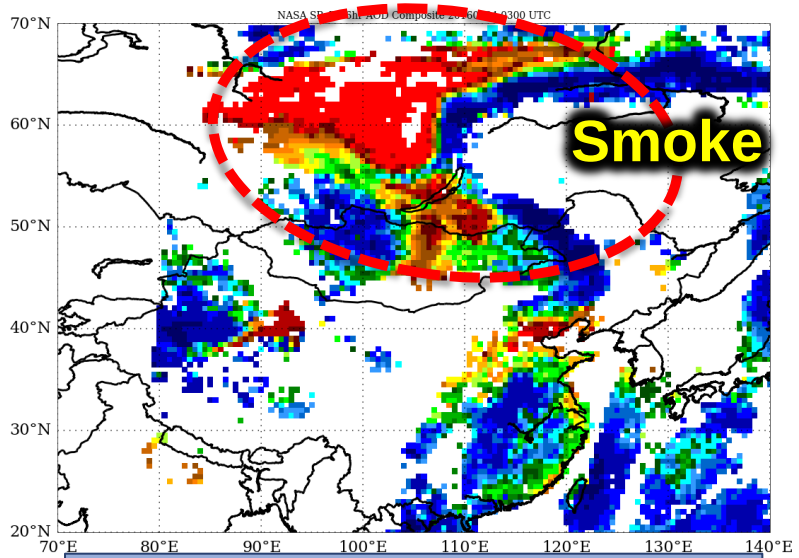

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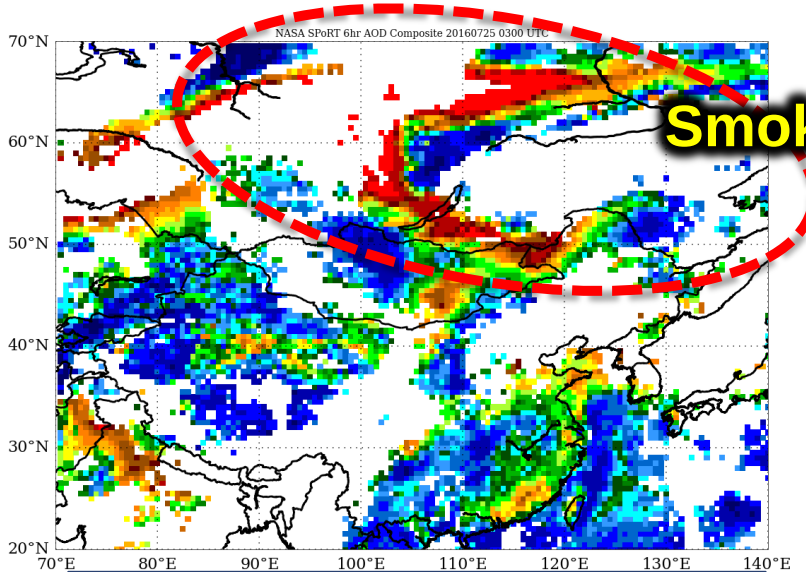

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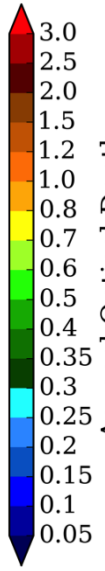
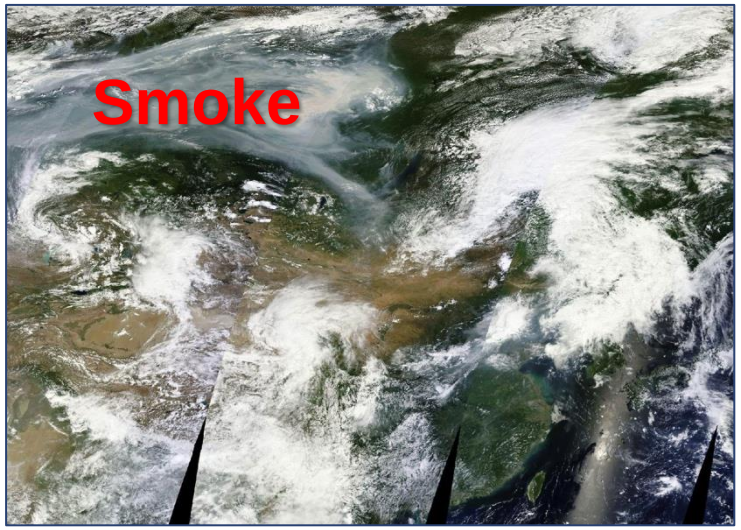
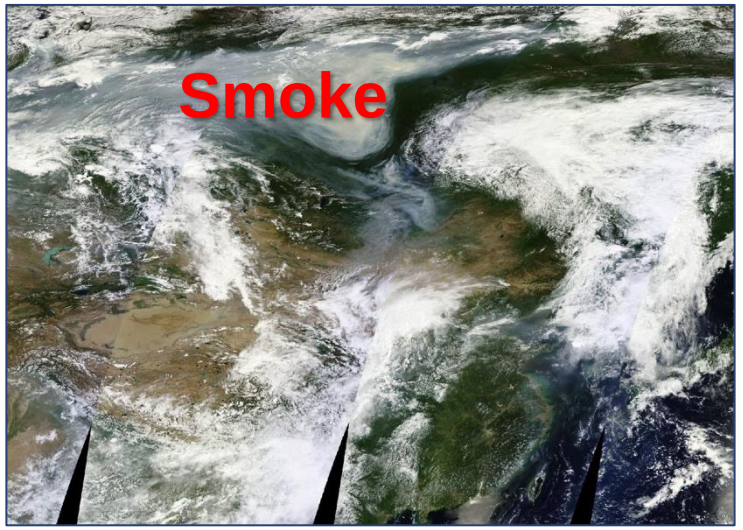




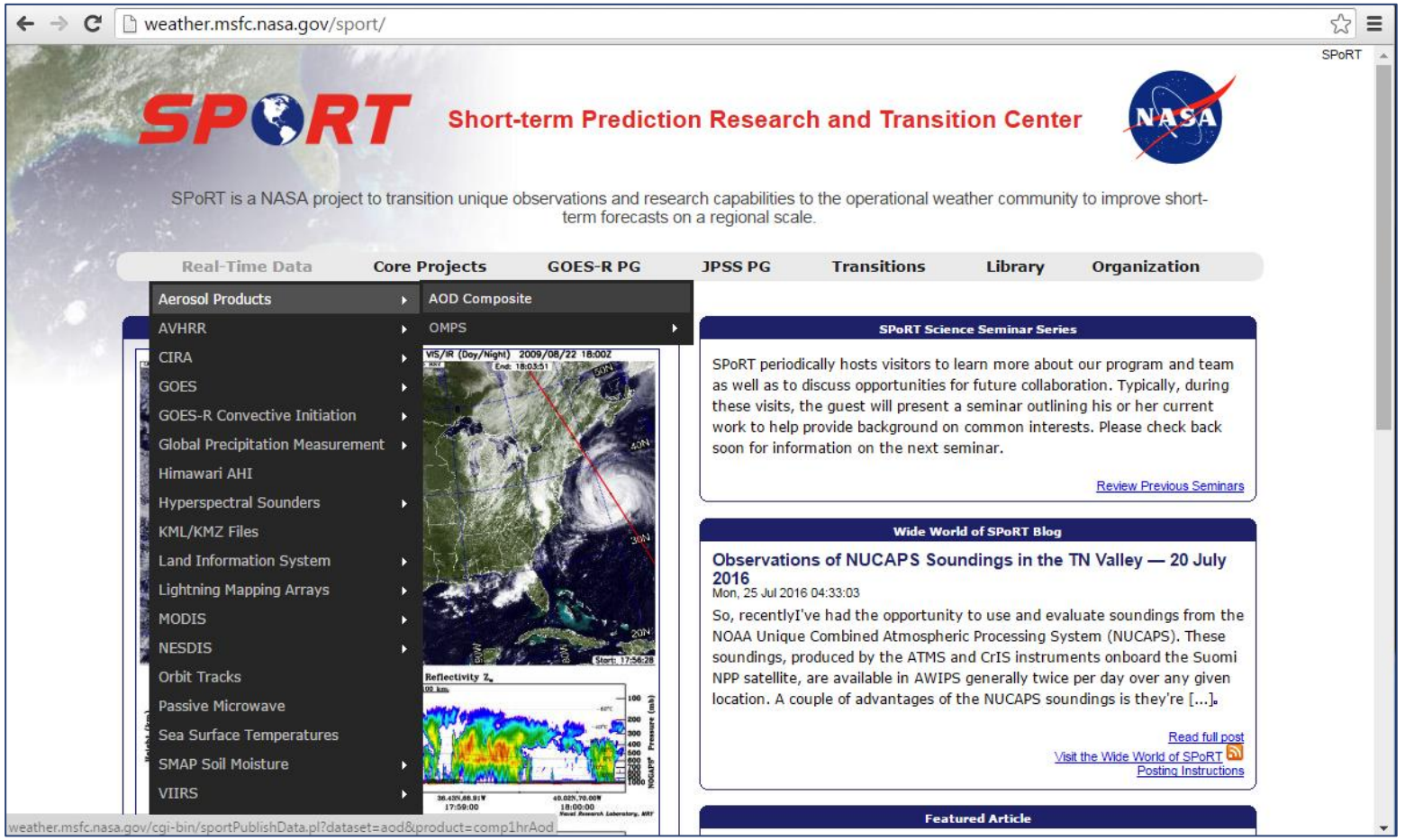


Future Work (1)

- Develop refined, more robust AHI aerosol retrieval algorithm
  - Improve cloud screening technique to reduce cloud contamination issues
  - Improve surface reflectance retrieval
  - Extensively validate the AHI algorithm against intensive field measurements during KORUS-AQ
- Separate between aerosol types (i.e., dust, pollution, smoke)
- Increase spatial resolution of AOD Composite Product (i.e, 0.2°x0.2° grid domain)
- Extend refined AHI algorithm to Geostationary Operational Environmental Satellite R-Series (GOES-R) which is planned for launch November 2016

Data Access and Display (1)

- NASA Short-term Prediction Research and Transition (SPoRT) Center
  - http://weather.msfc.nasa.gov/sport/
  - Real-Time Data Tab
    - Aerosol Products
    - AOD Composite
  - We maintain a 7-day archive of our hourly, 3-hourly, 6-hourly, and daily AOD Composite imagery
    - Looping capabilities
    - View in Google Earth
  - netCDF and KML archive starting 1 May 2016 is accessible for users via anonymous ftp server
    - ftp.geo.nsstc.nasa.gov
    - cd anaeger



Data Access and Display (2)

SPoRT AOD Daily Composite with central time of 0000 UTC 24 July 2016